Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

Dissertation

Auto-capture Selfie by Detecting Smile App

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Overview

- Background
- Motivation
- State of Art
- System Design
- Implementation
- Demo
- Conclusion and Future work

Background

Background

- Selfies have become an integral part of social media, serving as a means of self-expression, identity formation, and a way to communicate with others.

- Popular platforms such as Instagram, Snapchat, and TikTok are built on the concept of sharing these visuals, fostering a culture where the selfie is not just a photo, but a powerful tool of personal branding.

Background

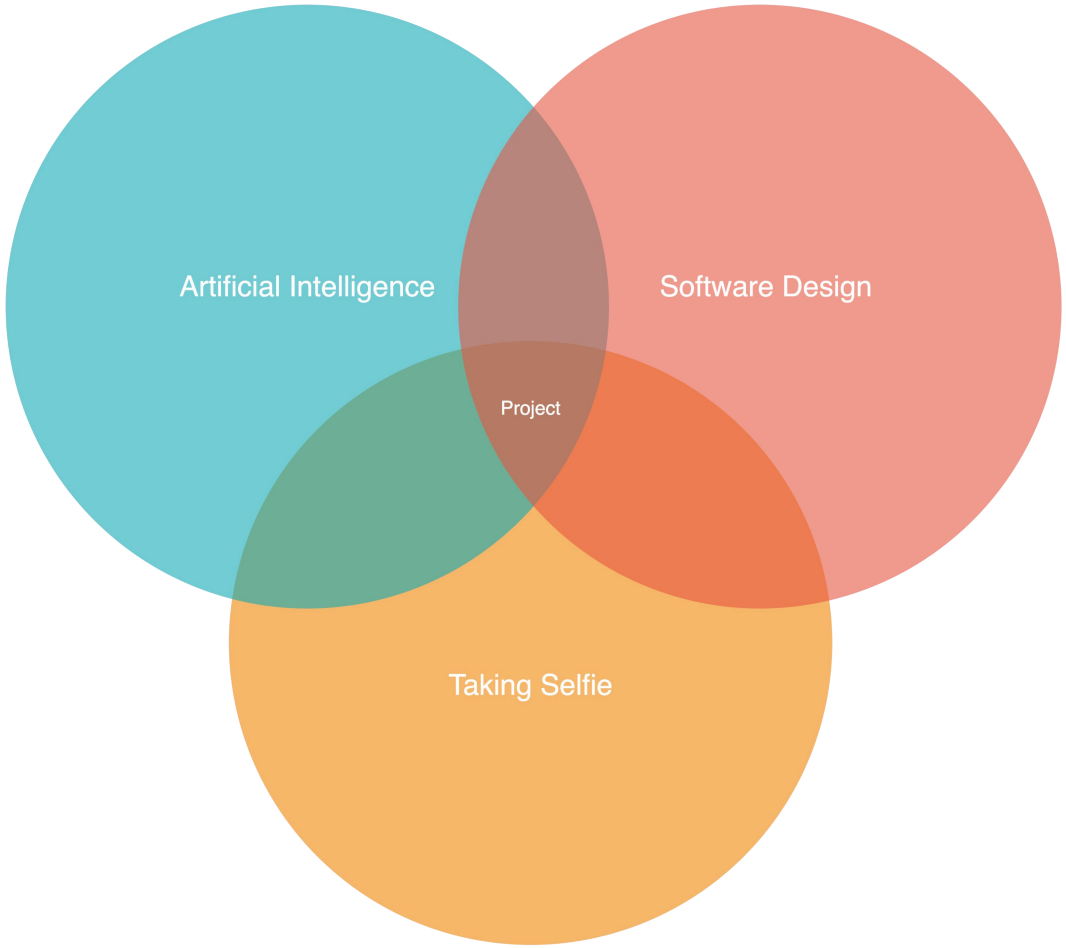
- Unflattering angles or expressions
- Timing

Motivation

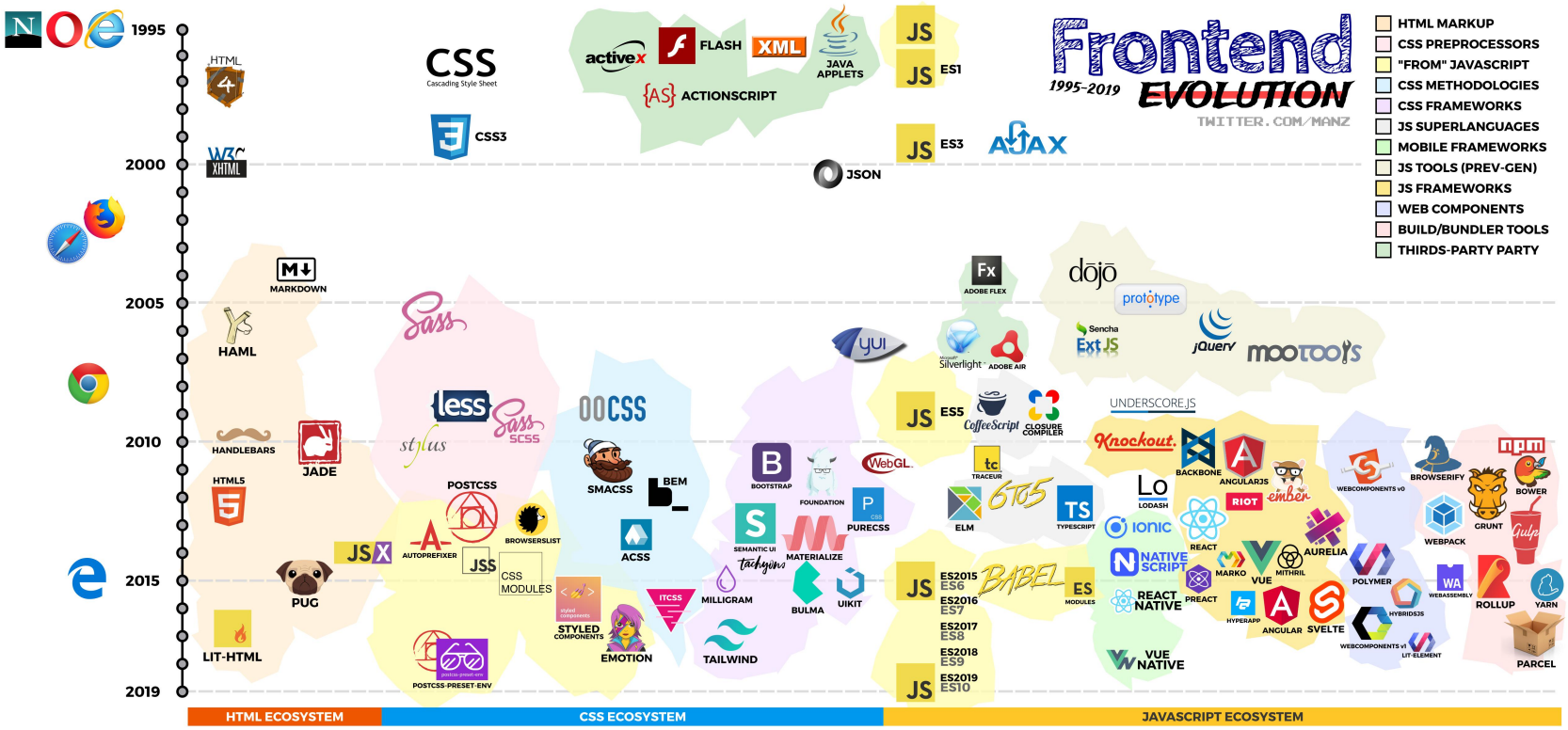
- Limelight application areas
- Lack of functionality to capture selfies based on facial expressions
- Many users are in need of such a feature

Motivation

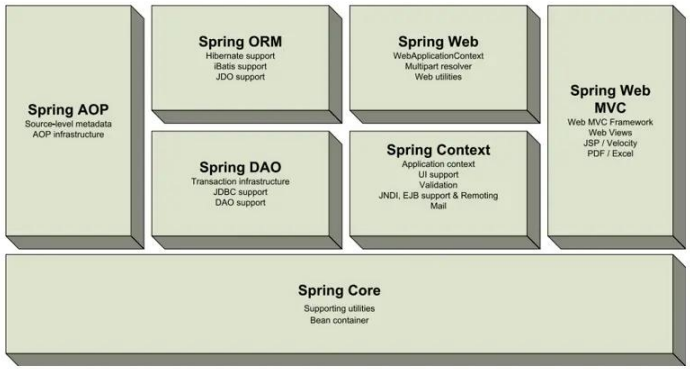
What if we integrate them



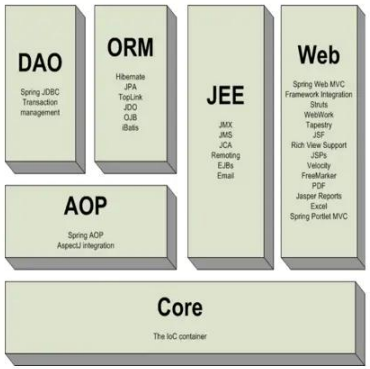
The state of art: Web Development



The state of art: Spring Framework



1.x



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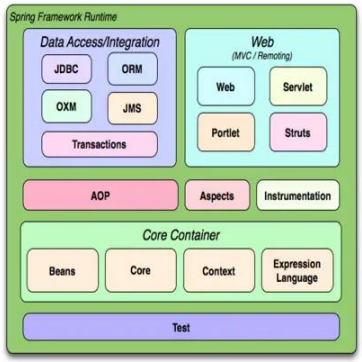
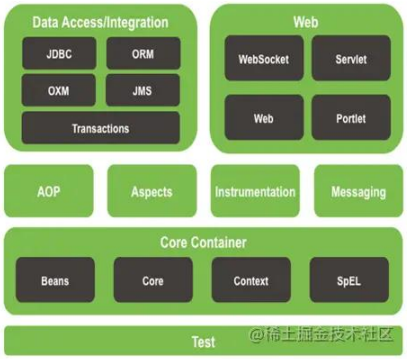
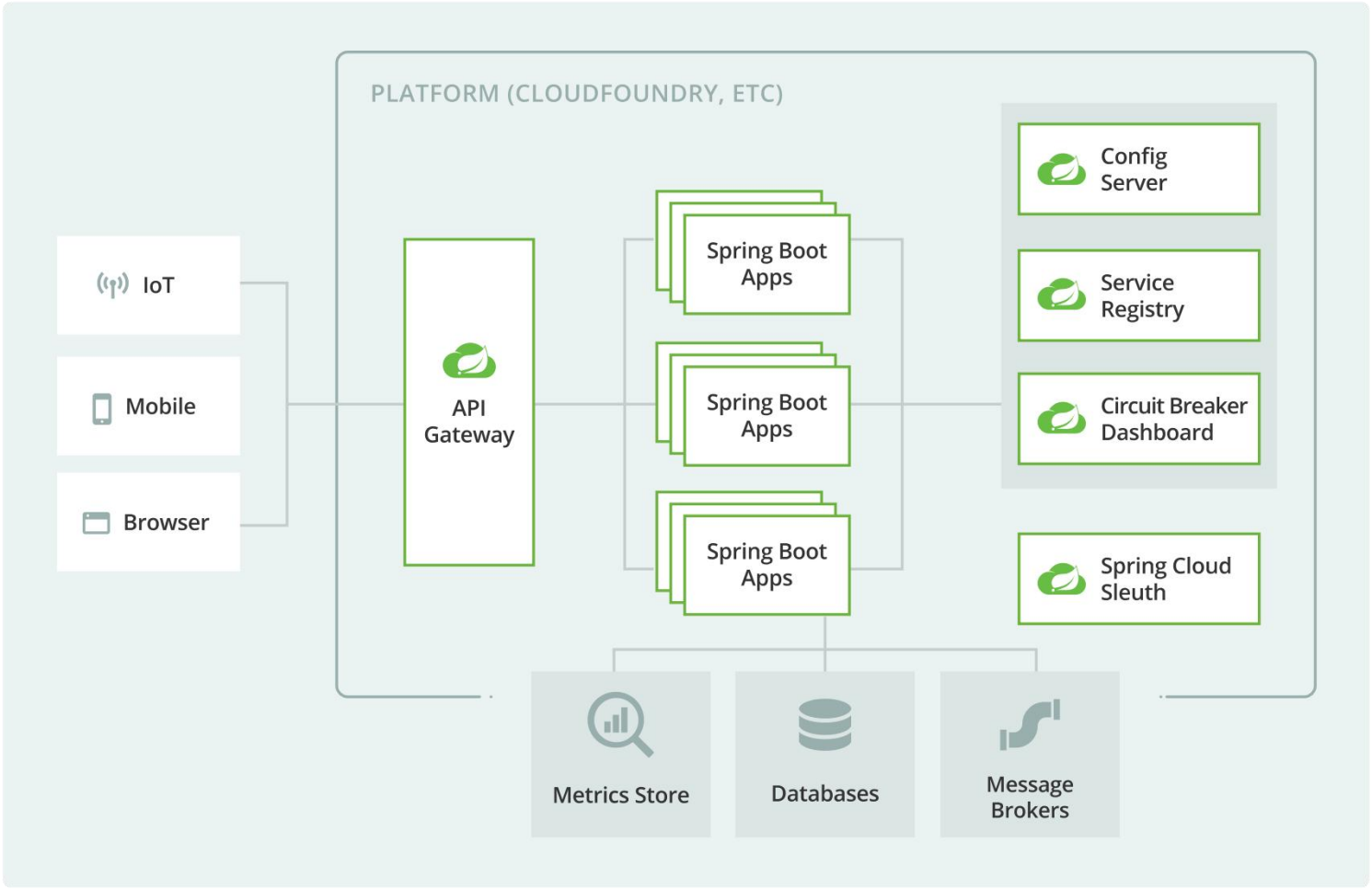


3.x

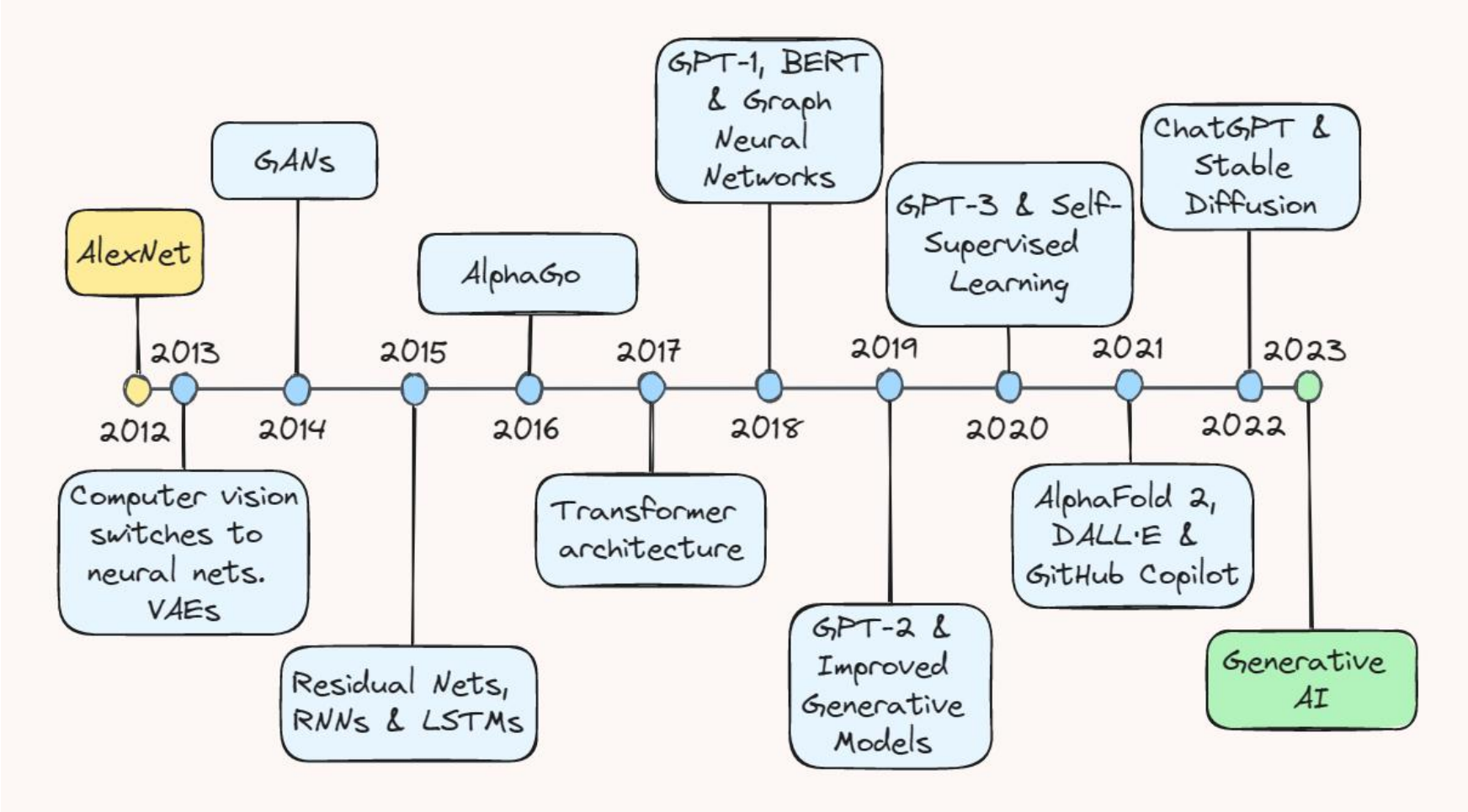
4.x



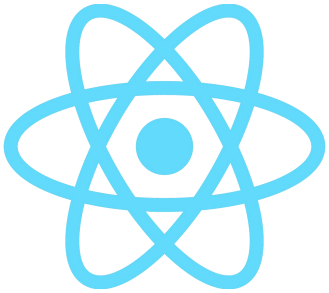
The state of art: Morden Spring



The state of art: Artificial Intelligence



Frontend Design: Framework



Backend Design: Framework

Backend Design: API

	REST	SOAP	GraphQL	RPC
Format	XML, JSON, HTML, plain text	XML only	JSON	JSON, XML, Protobuf, Thrift, FlatBuffers
Learning Curve	Easy	Difficult	Medium	Easy
Community	Large	Small	Growing	Large

Backend Design: Services

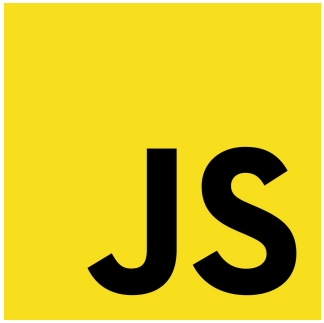
	Microservices	Monolith	MVC
Scalability	High	Low	Medium
Complexity	High	Low	Medium
Development Speed	Medium	High	High
Flexibility	High	Low	Medium
Fault isolation	High	Low	Medium

Backend Design: Container Orchestration

	Kubernetes	Docker Swarm	Apache Mesos
Networking	High	Medium	High
Security	Medium	Medium	Medium
Observability	Medium	Low	Medium
Extensibility	High	Low	High
Community	Large	Large	Medium

Backend Design: Facial Expression Recognization

vs



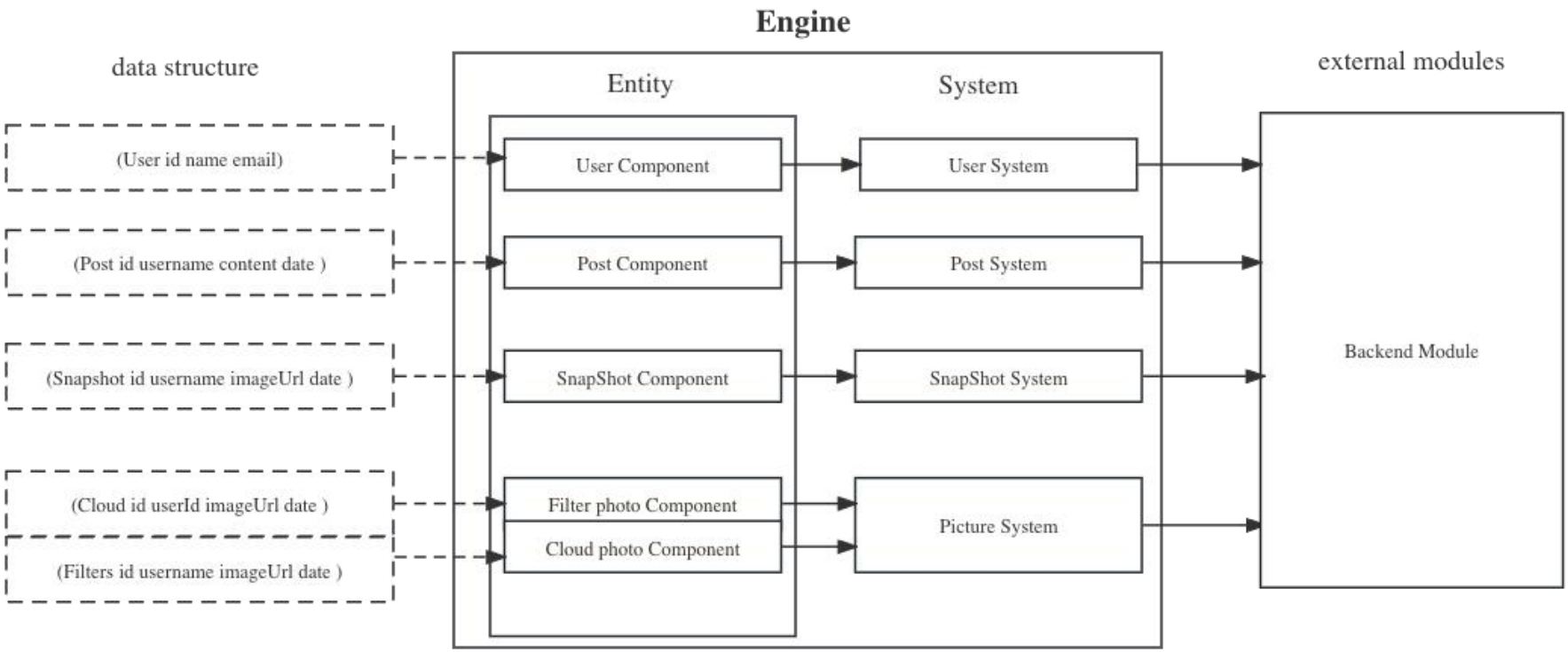
TensorFlow

MediaPipe Face Mesh

Frontend Implementation

- Pages
  - User Register, Login, Profile
  - Auto capture selfies
  - Photo Presentation
  - Post Bar
- Built in Ionic + react
  - Ant Design Mobile: Ant Design Mobile is a UI library for React that provides a set of customizable and mobile-friendly components. It is used for styling the UI elements like cards, buttons, sliders, and pickers.
  - MediaPipe Face Mesh: MediaPipe Face Mesh is a machine learning model used for face detection and facial landmark recognition. It is leveraged to track facial features in real-time from the webcam video feed.

Entity Representation



Backend Implementation

- Built in Java 17
  - Modules include authentication, authmatically detect an expression and take selfies, photo synchronization, post forum
  - Split the modules into microservices using Spring Cloud
  - Spring Boot for Restful API
  - Infrastructures include AWS S3, Mongodb Altas, Docker, Kubernetes
- Backend is **entirely decoupled** from frontend
  - Allows for plugging in of different backend modules

Database Design: Mongodb + Redis

```
_id: ObjectId('64bbdd25e085c75b23c9cfcf')
author: "Jiaming Deng"
createTime: 2023-07-22T13:44:05.804+00:00
title: "Sample Post"
content: "This is the content of the post."
img: "https://example.com/sample-image.jpg"
likes: 0
▸ comments: Array
▸ tags: Array
```

Post

```
_id: ObjectId('64aae63fca6e447444ed7cce')
email: "a@a.com"
password: "123"
username: "a"
signature: "Hello, world!"
role: "user"
status: "inactive"
token: "abcd1234"
avatar: "avatar.jpg"
registerTime: 2023-07-09T10:30:00.000+00:00
timeZone: "UTC+1"
```

User

```
comments: Array
▾ 0: Object
    author: "John Doe"
    content: "This is a great post!"
    createTime: 2023-07-22T13:44:26.151+00:00
```

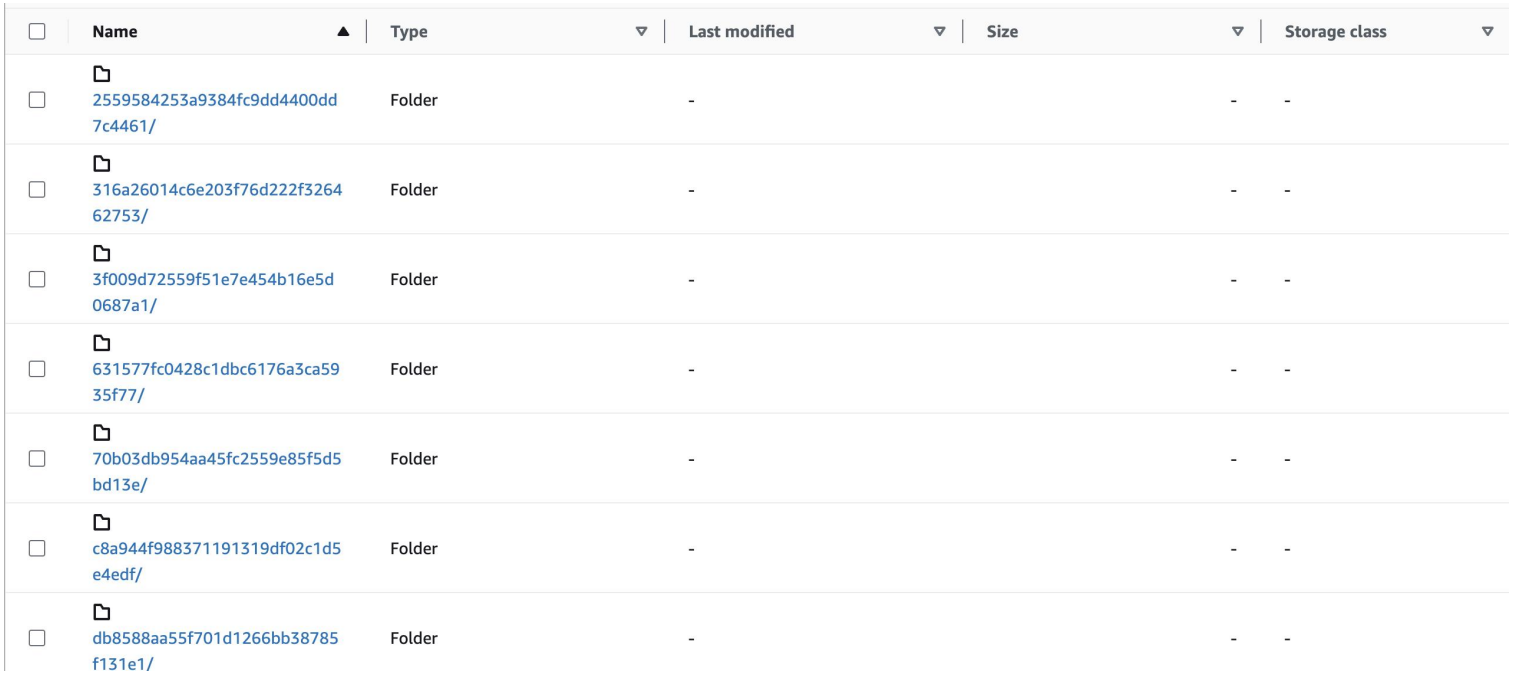
Comment

API Design

- Authentication: prefix /api/auth
  - /register, /login, /login_remember
- Photo: prefix /api/storage
  - /upload, /get/all, /get/{username}/{photo_name}
- User: prefix /api/profile
  - /update, /reset_email, /reset_password
- Post: prefix /api/post
  - /create, /update, /delete, /view/{post_id}, /view/tag/{tag}, /view/all, /comment/create, /like, /unlike

Infrastructure: AWS S3 Storage Buckets

- Scalability
- Durability and High Availability
- Security



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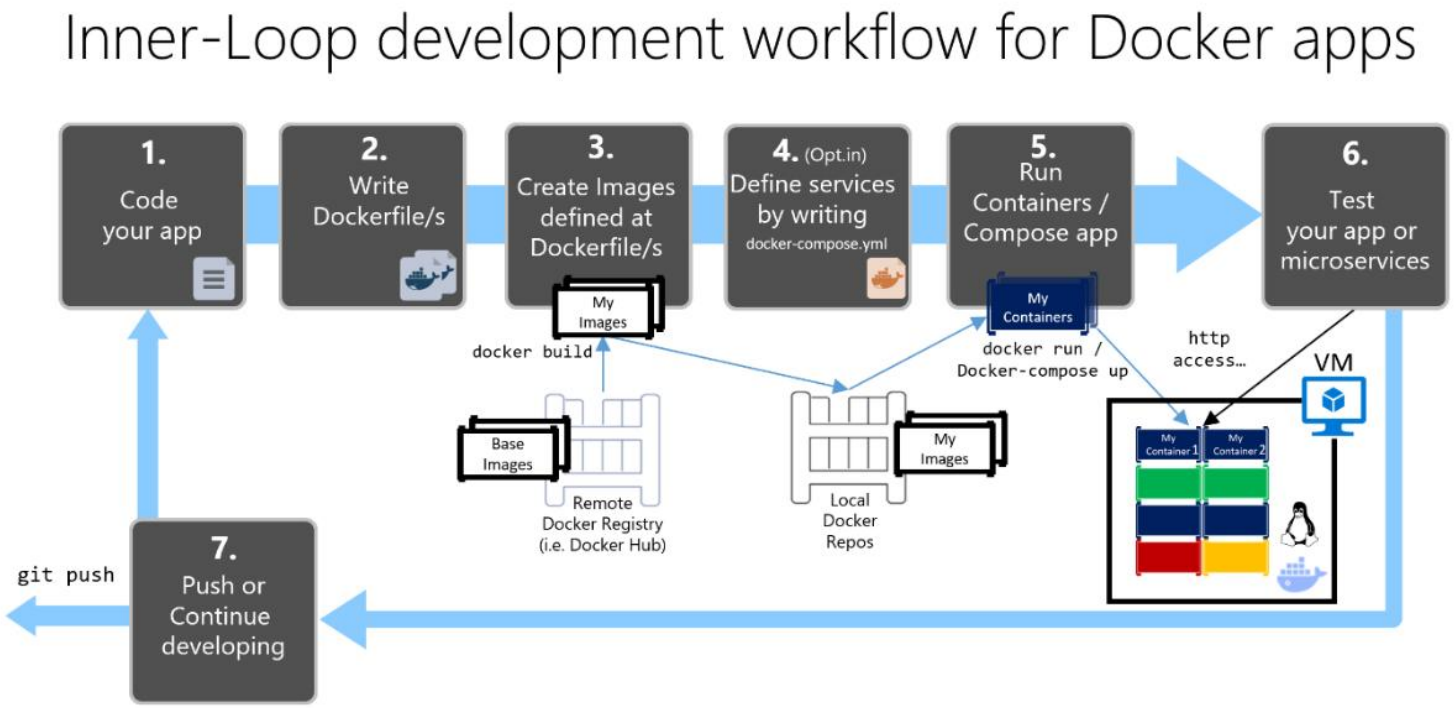
316a26014c6e203f76d222f326462753/	Folder	-	-	-
3f009d72559f51e7e454b16e5d0687a1/	Folder	-	-	-
631577fc0428c1dbc6176a3ca5935f77/	Folder	-	-	-
70b03db954aa45fc2559e85f5d5bd13e/	Folder	-	-	-
c8a944f988371191319df02c1d5e4edf/	Folder	-	-	-
db8588aa55f701d1266bb38785f131e1/	Folder	-	-	-

Infrastructure: Altas Mongodb Clusters

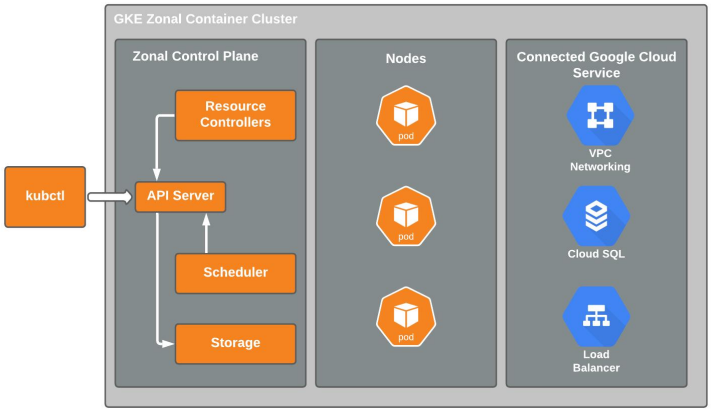
- Scalability and Performance
- Global Data Distribution
- Real-time Monitoring and Analytics

Infrastructure: Docker

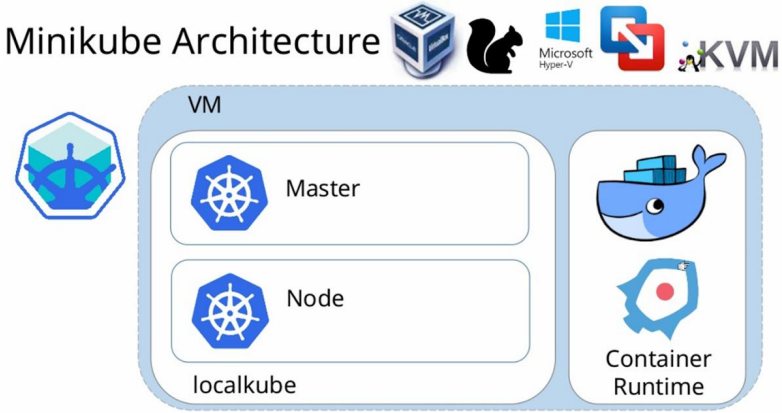
- Basic **Docker images** containing all of microservices
- Docker **overlay network** to connect all docker nodes together



Infrastructure: Kubernetes



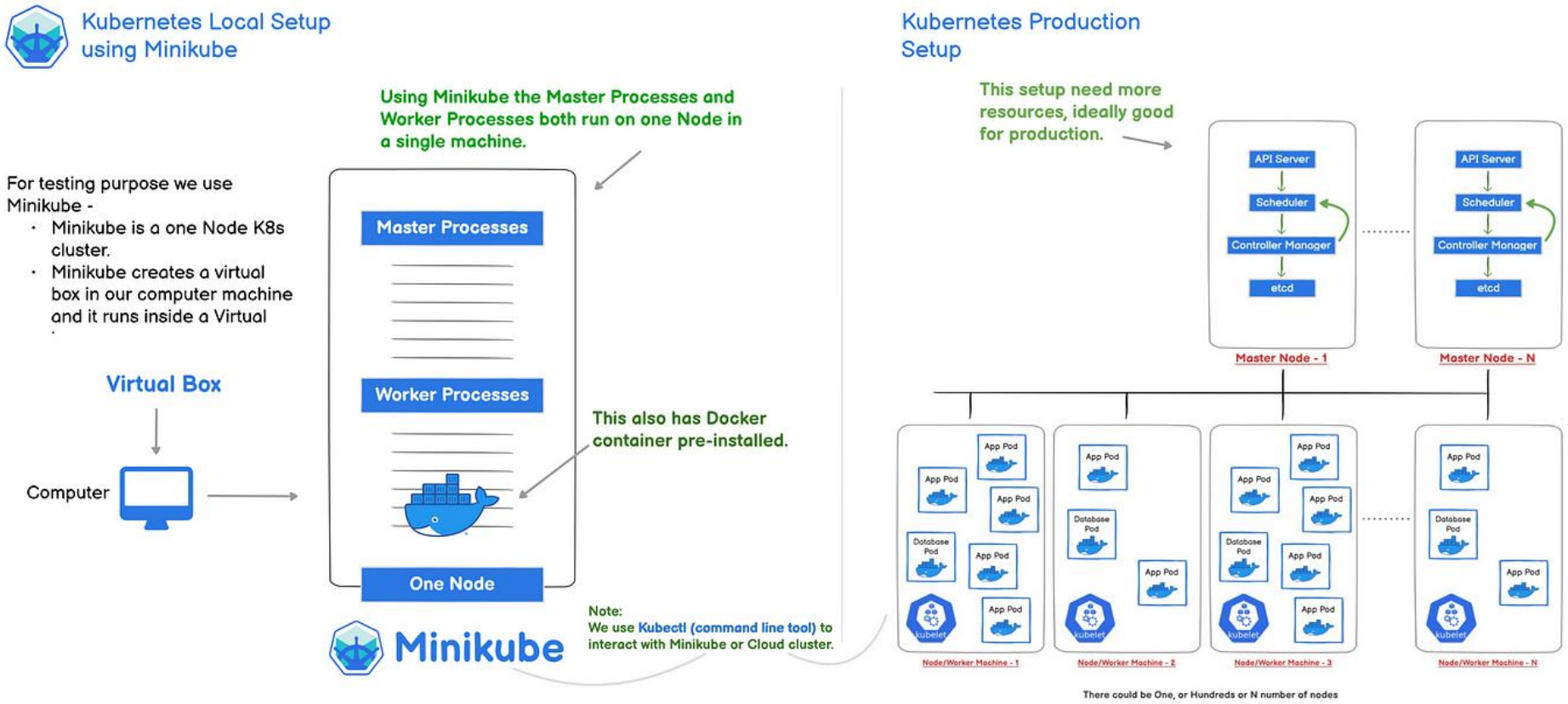
VS



Google Kubenetes engine

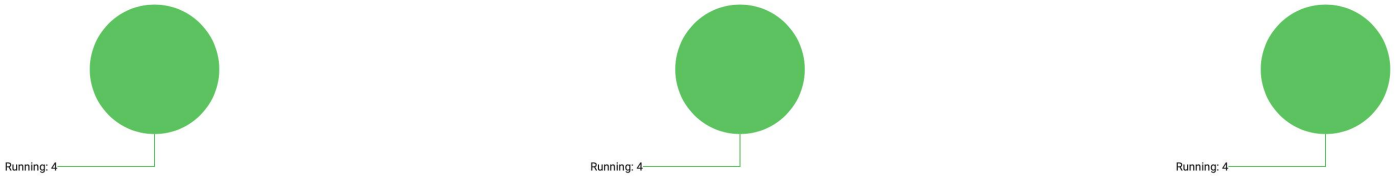
minikube

Infrastructure: Minikube



Infrastructure: Minikube

Workload Status



Deployments

	Name	Images	Labels	Pods	Created ↑	
●	userprofile	ysfsblj/userprofile:v1	app: userprofile	1 / 1	an hour ago	⋮
●	authentication	ysfsblj/authentication:v1	app: authentication	1 / 1	an hour ago	⋮
●	photo	ysfsblj/photo:v1	app: photo	1 / 1	an hour ago	⋮
●	post	ysfsblj/post:v1	app: post	1 / 1	an hour ago	⋮

Pods

	Name	Images	Labels	Node	Status	Restarts	CPU Usage (cores)	Memory Usage (bytes)	Created ↑	
●	photo-7b49c945d-hqz7j	ysfsblj/photo:v1	app: photo pod-template-hash: 7b49c945d	minikube	Running	0	3.00m	164.16Mi	an hour ago	⋮
●	userprofile-5c947d97fd-hqwqq	ysfsblj/userprofile:v1	app: userprofile pod-template-hash: 5c947d97fd	minikube	Running	0	2.00m	159.58Mi	an hour ago	⋮

Deep learning: MediaPipe Face Mesh

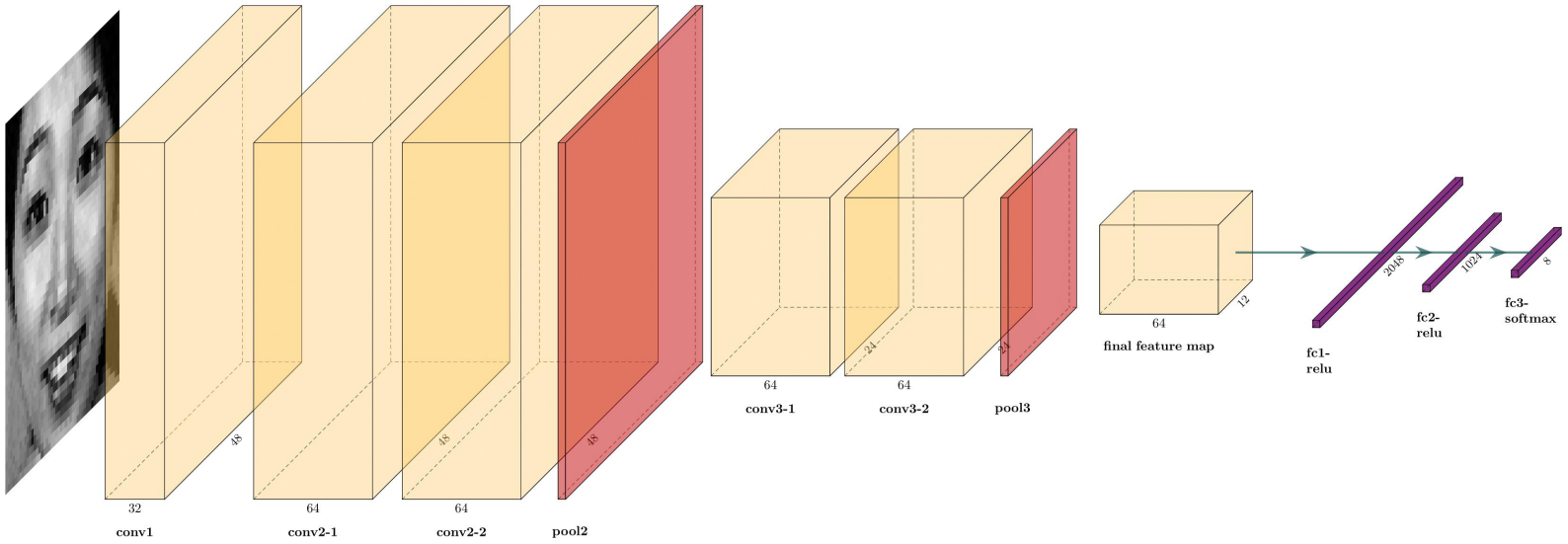
- Real-time webcam video stream
- Face Detection
- Facial Expression Analysis

Deep Learning: Dataset and Model

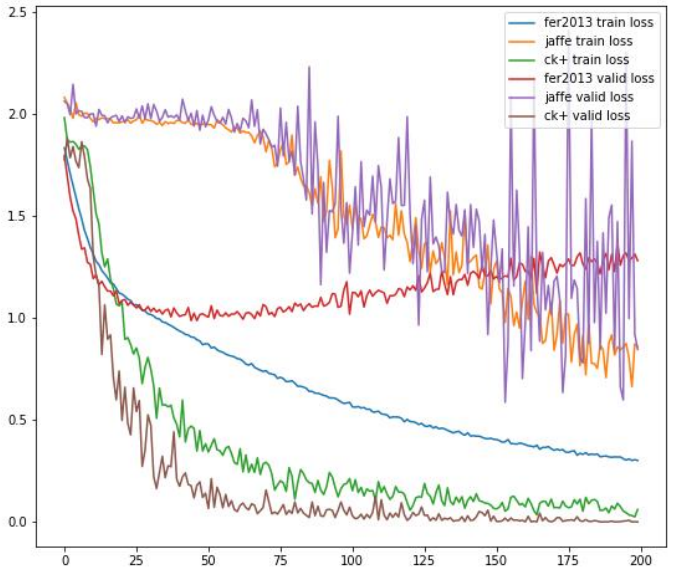
Training Dataset: Fer2013, Jaffe and CK+

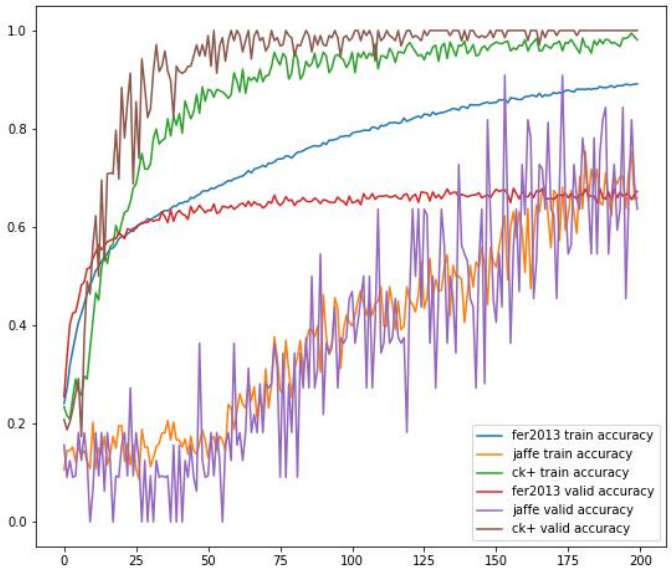
Face Detect: Google BlazeFace Algorithm

Feature Extraction and Classification: Traditional CNN

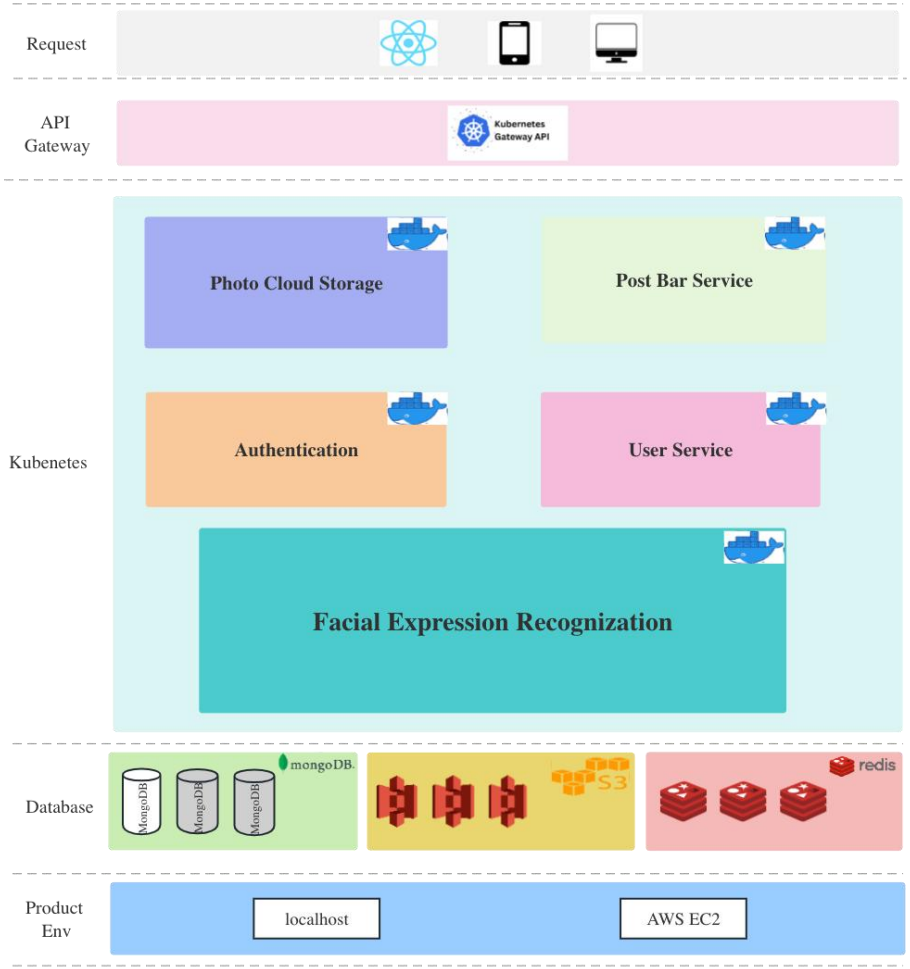


Deep Learning: Training

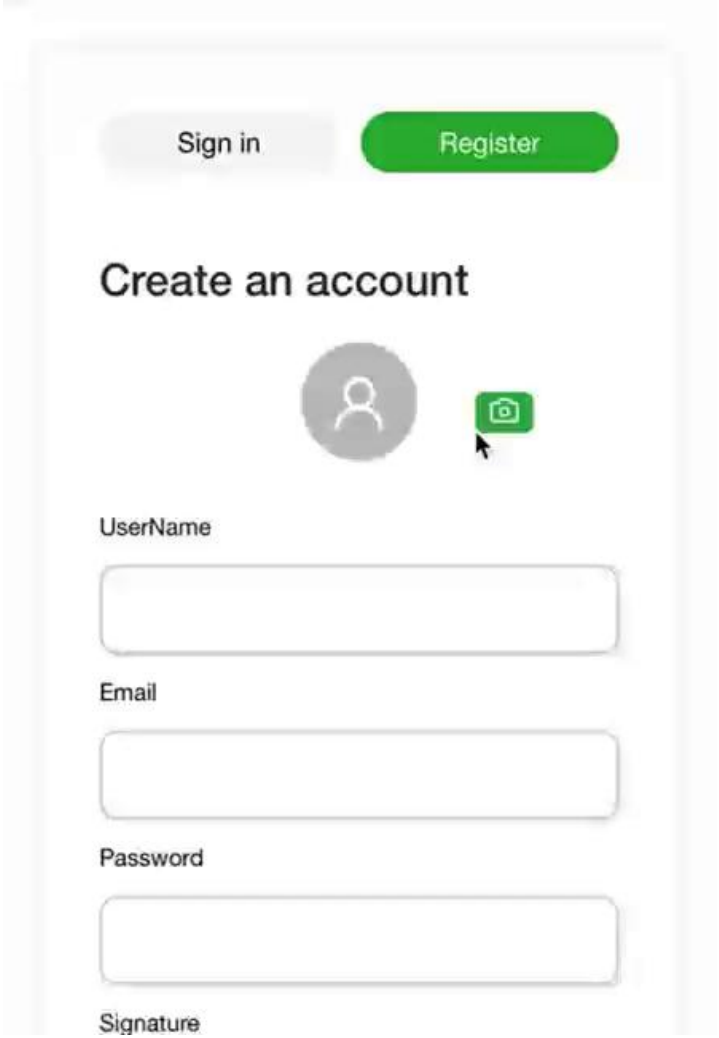




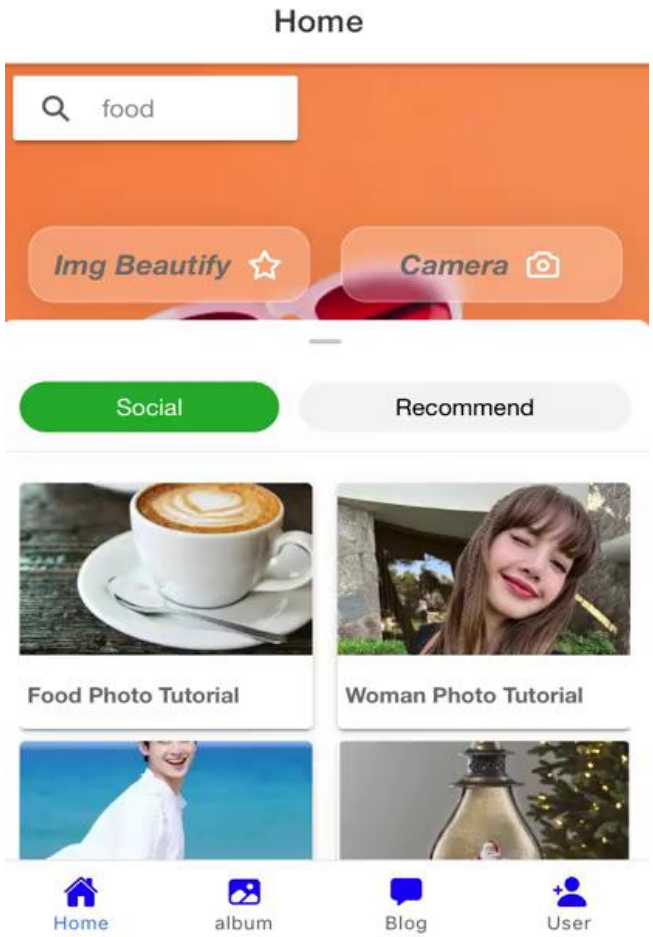
Project Structure



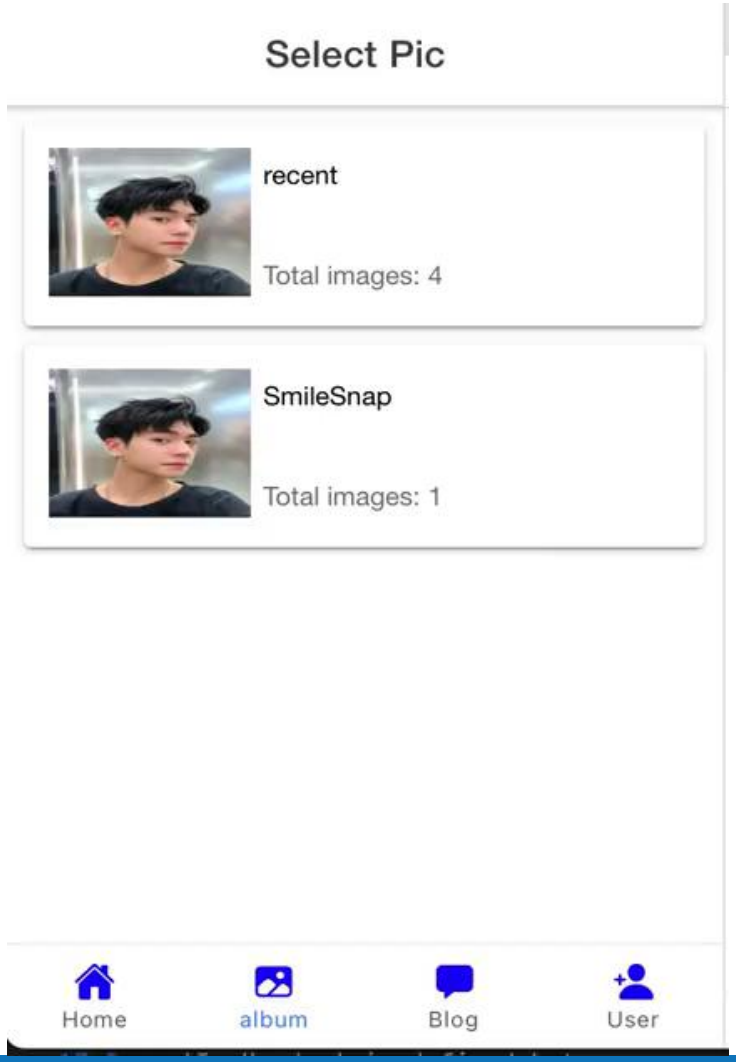
Demo: Authentication



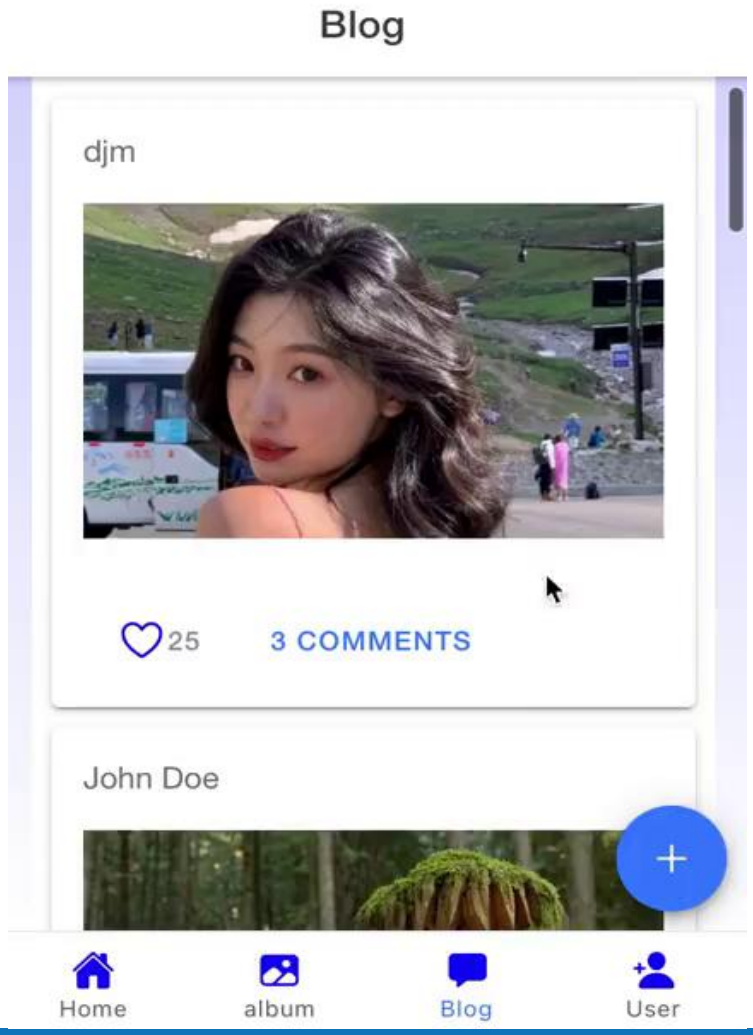
Demo: Automatically detect smile



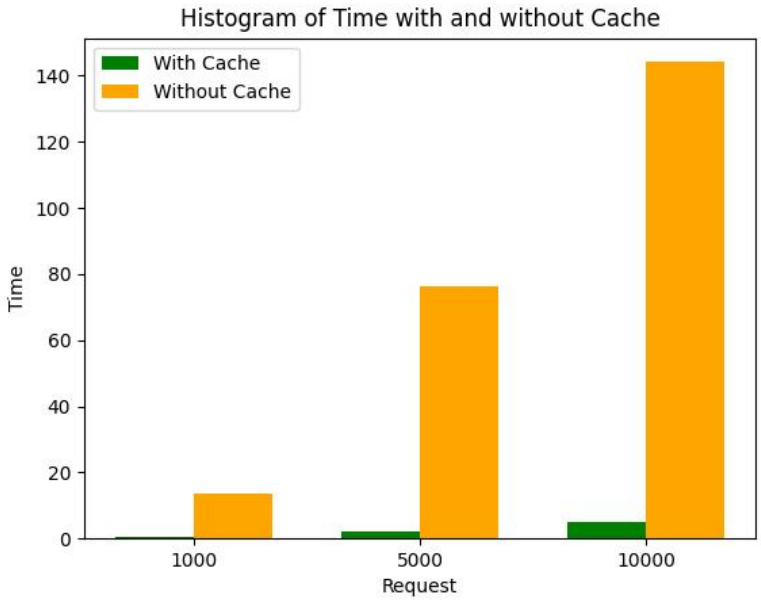
Demo: Photo Sync

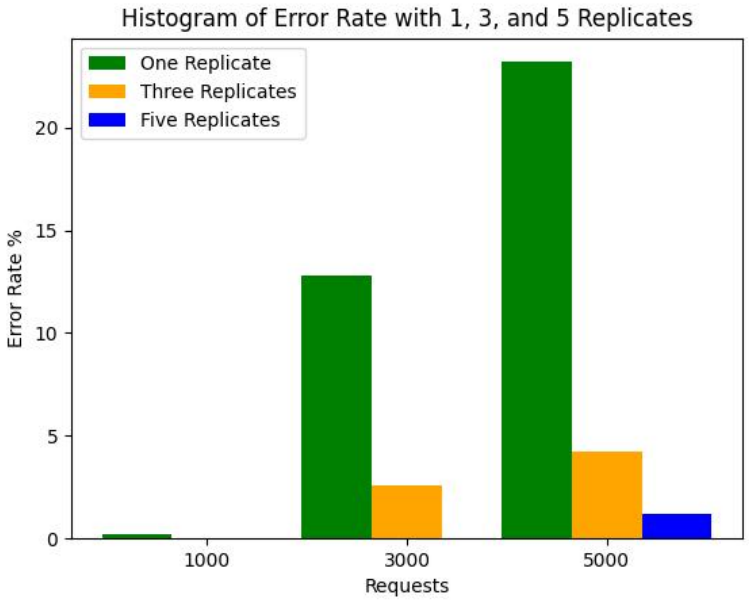


Demo: Post Bar



Test


Histogram of Time with and without Cache
With Cache
Without Cache
Time
0
20
40
60
80
100
120
140
1000
5000
10000
Request


Histogram of Error Rate with 1, 3, and 5 Replicates
One Replicate
Three Replicates
Five Replicates
Error Rate %
0
5
10
15
20
1000
3000
5000
Requests

Conclusion

- Frontend:
  - Ionic: Build cross-platform mobile applications for web/android/iOS, etc.
  - TypeScript: A strongly typed programming language based on JavaScript, better tooling at any scale.
- Backend:
  - Spring Boot: Develop Restful API
  - Spring Cloud: Implement microservices
  - Kubenetes: Container orchestration
  - AWS S3: Cloud db for multimedia file
  - MediaPipe Face Mesh: Facial expressions recognization
  - MongoDB: Nosql db for user, post and comment data storage
  - Redis: Memory db for cache

Future work

- Enhanced User Experience
- Security and Privacy Measures
- Performance Optimization

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Thank You !

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Questions ?